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Distributed Distribution: Here, There, Everywhere

BY KEVIN WERBACH

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Getting content where it needs to go, when and how it needs to get there, isn't just a question of bandwidth but of architecture. File sizes are growing faster than network owners can upgrade their physical infrastructure. Services such as streaming audio and video need specific quality-of-service guarantees. Some content relates to other content stored on a different server or at another company. And cost is a real factor. Providers can't afford to spend more on bandwidth than they charge end-users, and enterprises are hesitant to continue the cycle of budget-busting network upgrades so their employees can make use of internal portals and other resources.

Online content distribution is difficult because it's an any-to-any challenge in an uncontrolled, fast-changing environment. A solution is to turn the problem on its head, with a decentralized response to a decentralized challenge. Hence the seemingly redundant distributed content distribution. Services built on this approach optimize under-used bandwidth and storage resources within networks over space and time. They seek to change the economics for moving large files and delivering streaming media. Along the way, they demonstrate real business uses for peer-to-peer architectures.

In the physical world we have many delivery options to choose from. The post office will (pretty much) get your letter there, but it could take several days. Pay more and FedEx or Airborne will guarantee overnight delivery. For a large box, you may use UPS. If your letter has to get across town right away, a courier service will pick it up. Or maybe the best alternative isn't to send the physical document at all, but to fax or email it (though that won't work for a bou-

{ *continued on page 2* }

quet of roses!). All these delivery options have different profiles of price, speed, reliability, confidentiality and capacity.

We lose this range of choices when we go online, because the Internet offers only "best-efforts" delivery. There's no guarantee that any packet will arrive within a given amount of time, or that it will arrive at all. That's actually a feature, not a bug. Best-efforts delivery avoids the need for complex management mechanisms hardwired into the network. Anyone can add a new network, put up a Web page or create a service that runs on the Internet, without having to coordinate with a central authority. Best-efforts also drastically reduces the cost of a ubiquitous data network.

Better Than Best-Efforts

Best-efforts works fine for most Net traffic, but there are situations where better performance is essential (as with streaming media), delivery must be guaranteed (as with financial transactions) or the necessary bandwidth is cost-prohibitive. Many mechanisms exist to address the Net's performance limitations, including quality-of-service management (SEE **RELEASE 1.0**, JUNE 1998), content-delivery networks (CDNs) (SEE **RELEASE 1.0**, DECEMBER 1999), realtime messaging (SEE **RELEASE 1.0**, DECEMBER 2001) and guaranteed message delivery (companies such as Slam Dunk Networks).

Distributed content distribution operates at a higher level than these other technologies. It focuses on end-to-end delivery of replicated objects or streams instead of packets or code. It differs from CDNs such as Digital Island and Akamai that are now widely used by popular Websites, because these services optimize distribution from Web hosting facilities only to the edge of the public Internet, not all the way to a particular desktop.

Distributed distribution creates multiple copies of each object and uses smart algorithms to pull data from nearby sources, including other users. Because it involves replication, it works well for one-to-many scenarios, such as streaming video broadcasts and downloads

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from a Web page. The economics of the distributed approach improve as the same content goes out to a larger audience. Point-to-point solutions focused on transactions or guaranteed delivery of individual messages generally use different approaches. If every piece of content is unique, there's no advantage to be gained by distributing multiple copies.

It's a small world after all

As we describe below, most distributed distribution services use a peer-to-peer (P2P) architecture. (Radiance, discussed on page 13, is the major exception.) The P2P services use client software that pulls the desired content or media stream from nearby users, instead of going back to a central server. In effect, every node on the network turns into a caching server.

P2P content distribution takes advantage of what sociologists call the small-worlds phenomenon, better known as "six degrees of separation." In a famous experiment in the 1960s, psychologist Stanley Milgram sent letters to a random list of people in Omaha, Nebraska, and told them the goal was to get the letters to a stockbroker in Boston, whom none of them knew personally. Each recipient sent the letter on to a friend he or she thought was closer to the stockbroker in some way. The friends sent the letters along, and so forth. On average, in a country of 200 million people, it took just six hops for the letters that arrived to get to the designated recipient. (SEE RESOURCES SECTION FOR REFERENCES.)

Small-worlds behavior isn't limited to human networks (SEE **RELEASE 1.0**, FEBRUARY 1996). Big computer networks can act small if the nodes within them have some intelligence and adaptability. P2P content distribution services exploit this, but in a different way from search engines such as Google that use link structure on the Web to indicate relevant pages (SEE **RELEASE 1.0**, JANUARY 1999). The difference is that the people with the content you want aren't consciously pointing to it, and the content distribution service has to work in realtime to create the illusion that you're getting the file from one place.

The small-worlds phenomenon is an example of self-organization in action. Many unconnected local decisions take the place of a central organizing mechanism. Says Uprizer co-founder Ian Clarke (SEE PAGE 9), describing his company's technology: "This is, to my knowledge, one of the first practical applications of a distributed self-organizing system which relies on emergent properties."

Market opportunities

There are two primary markets for distributed distribution: enterprises (primarily within a single company or gated extranet) and open/public consumer media. For enterprises, the problem is the lack of bandwidth to deliver the increasing volume of large files. Upgrading the pipes to keep up is ultimately a vicious cycle, as Radiance ceo Ash Munshi explains: "The amount of content will always overwhelm any amount of bandwidth that has been provisioned, in a small period of time. When people see that more bandwidth has been added, they send larger files. You need to be able to monitor and manage that bandwidth in an effective way."

When it comes to digital media, we usually think about couch potatoes watching video-on-demand and teenagers burning pop music CDs with music they downloaded through Napster. But that's only part of the story. A large and growing amount of rich media gets distributed within businesses, in the form of presentations, Webinars, training videos, investor conference calls and so forth. "When you look at the traffic that's on the Net and how it's going to grow over the next five years or so, most people believe it will grow 40-to-80 percent a year," observes Kontiki ceo Mike Homer (SEE PAGE 7). "The majority of that traffic growth will come from digital media, as opposed to simply the expansion of Web-page serving."

Unlike the public Internet, where small pipes at the edges feed into massive backbones, most corporate networks have plentiful bandwidth in the local area networks connecting machines, but limited capacity in the wide-area links between offices. That creates a significant advantage for pulling files from somewhere close to the user. Where in the past enterprises may have been willing to pay for more bandwidth, faster routers and proprietary caching servers, today they are looking for cost savings and better efficiency from their existing infrastructure.

This desire for more efficiency creates the immediate opportunity for distributed distribution vendors serving enterprises. These startups typically sell software or services based on the number of nodes or servers in the network, promising a strong return on investment from the cost savings they produce. Within a company or a network of business partners, IT managers have a degree of control over users, network topology and what goes on the desktop. Security and performance mean one thing when all content is behind a firewall, and something else when anyone can connect into your network.

Broadercasting

The consumer media opportunity is farther out, because few consumers today are paying for rich-media content over the Internet. When they begin to, however, distributed mechanisms will be important. . . and there will be revenue to go around. And as we recently argued, digital media may be closer to taking off than most people think (SEE **RELEASE 1.0**, NOVEMBER 2001). Distributed content distribution won't make broadband roll out faster, but it will facilitate applications such as streaming radio and video-on-demand.

As noted earlier, the Internet is inherently unpredictable, so there's no way to guarantee reliable high-bandwidth transport from end-to-end, especially for rich media that is highly sensitive to latency. The traditional way to overcome this problem was to throw bandwidth at it, using bigger pipes or more extensive managed networks. But that quickly becomes expensive. The streaming-media industry has struggled to find viable business models when shrinking advertising revenues can't make up for bandwidth costs.

Fundamentally, there's an economic disconnect between the mass-media business and the Net (SEE **RELEASE 1.0**, NOVEMBER 1999). Blue Falcon ceo Jay Haynes (SEE PAGE 12) states the problem using radio as an example: "In terrestrial broadcasting, radio is a great business. If two people listen to your broadcast instead of one, the costs are the same. But online that's not the case, because every listener is using bandwidth and origin server resources." The Net's great advantage – allowing content to be customized or made interactive for each users – is its undoing when it comes to content that is designed for broadcasting out to many people.

Distributed distribution makes the economics of online media distribution more closely resemble offline broadcasting. Every customer added to the network becomes not just a consumer but a potential server of content. As a result, the volume of content transmitted from the origin doesn't increase nearly as fast as the number of listeners or viewers.

Moreover, by putting in place an end-to-end content infrastructure, distributed distribution services allow service providers and customers to make tradeoffs among mechanisms for delivering the same content. Do you want your movie streamed to you right now, or are you willing to wait two hours for a downloaded version at a lower price?

Unlike multicasting, which eliminates redundant media streams inside the network, distributed content distribution services can be deployed at the edges of the network, in end-user software or devices. Consequently, ISPs, hosting providers and everyone else in the distribution chain need not upgrade and coordinate their entire network infrastructure. This architecture also allows service providers to meter and bill for content on a per-use or subscription basis.

Radiance just announced a deal with Tivo to embed its content distribution technology into next-generation digital video recorder boxes. The Radiance client will support video-on-demand services delivered to the Tivo units. Radiance is now reaching out to CDNs (one of which has already signed an agreement) and content owners to license its server software to send programs to the new devices.

The Tivo deal raised some eyebrows, since Kontiki ceo Homer sits on Tivo's board, and Tivo was an early Kontiki customer. Tivo still uses Kontiki to distribute internal marketing and sales materials. Homer says that the non-PC media opportunity is too far in the future to focus resources on today, and that in any event, Kontiki could easily put its client on the Tivo platform as a third-party developer.

The Distributors

Quite a few startups are working on some form of P2P content delivery, though many have yet to see the light of day amid the current funding and customer spending crunch. The startups we describe here – Kontiki, Uprizer, Blue Falcon and Radiance – look to be the most substantial at this stage. Others in the space include Yaga, Chaincast, vTrails, Red Swoosh, EverNet, and Onion Networks (the former Swarmcast project at OpenCOLA; SEE **RELEASE 1.0**, NOVEMBER 2000).

It's early, but we can make some generalizations about the startups discussed below. All four use a combination of distributed nodes and central servers, with Radiance the most centrally controlled and Uprizer the most decentralized. All four say they intend to serve both enterprise and consumer media markets.

There are several distinctions. Blue Falcon concentrates on streaming audio and video; Kontiki primarily delivers downloadable media files but also handles documents and applications; Radiance and Uprizer focus on large files distributed within enterprises. Radiance primarily sells software while the others sell services, though in

the enterprise case the difference may be small because end-user software is part of the service. Kontiki has several paying customers today, Blue Falcon has a handful, and the other two companies are in pilots.

Kontiki: life raft for digital media

Kontiki is the most ambitious of the distributed content distribution startups. We discussed Kontiki's "delayed media" interface model in our recent look at the next phase of new media (SEE **RELEASE 1.0**, NOVEMBER 2001). The company's user-friendly desktop client functions as a program guide and manages content flows in a "hands-free" manner, downloading requested programs automatically. It does so transparently, monitoring PC usage so as to avoid slowing down the machine or the Internet connection when it's in use.

Equally interesting is what happens behind the scenes. The end-user software functions as a node in what Kontiki ceo Mike Homer calls a software-based secure media delivery network. "Since it's a software-based network without any significant central hosting requirements, the network is inexpensive to grow," explains Homer, "but it's also highly flexible, highly adaptable, reliable and secure."

KONTIKI INFO

Headquarters: Mountain View, CA
Founded: November 2000
Employees: 50
Funding: $18 million from Barksdale Group, Benchmark, Angel Investors LP and individuals
URL: www.kontiki.com

Kontiki's distributed network was designed to overcome the fundamental limitations of the Net as a distribution mechanism for media and other large files: unpredictable best-efforts delivery, and inefficient routing between Internet backbone networks (SEE **RELEASE 1.0**, JUNE 1998). The company calls its approach bandwidth harvesting. This includes P2P distribution, through which content can automatically be pulled from other nearby end-users instead of the origin server. The network optimizes for proximity, preferring to download content from users who are the fewest number of router hops away.

In addition, every client connects to multiple sources of the same content, and adaptively varies transmission speed based on the relative performance of each of them. This approach also provides fault-tolerance, because users aren't dependent on a single content source. Kontiki further lowers bandwidth costs with its use of scheduled delivery. Users can request content for delivery when it's available rather than download it immediately, which has the effect of shifting demand away from peak periods. At the election of the content publisher, users can have the option of streaming or downloading immediately.

ADVERTISING AT THE EDGE

Other startups are taking the distributed approach to a different market: online advertising. Ad-serving networks such as DoubleClick use CDNs to serve their banner images. However, they still rely on expensive central servers to select the appropriate ad to serve on a page, typically based on cookie files stored locally on a user's hard drive. Two startups have developed more distributed architectures for better scalability and targeting.

Zedo, based in San Francisco, CA, has developed a small piece of Javascript code that runs locally on each user's machine. (DISCLOSURE: ESTHER DYSON IS AN INVESTOR IN AND DIRECTOR OF ZEDO.) The local software reads the cookie and decides which ad to serve, from which CDN image cache. Because it requires only one request/response loop instead of two (to the image cache and to the targeting server), this approach provides better speed and scalability than current mechanisms.

Because it runs code locally, Zedo can offer pull-based targeting, through which users select the "channel" for the banners they see. It can also tailor the Javascript to each client, measuring different properties such as how many people moused over the ad or how long the ad was visible on screen. Zedo's co-founders are ceo Roy DeSouza, who was previously in product management at online city guide provider Zip2.com, and cto Alfredo Botelho, who previously developed Network Associates' firewall server product.

Computer industry veteran Denny Bollay, who developed several pioneering projects including expert systems and database-driven Web applications, is also working on decentralized advertising. But there's a twist. ExperClick, a subsidiary of Bollay's Santa Barbara, CA, firm ExperTelligence, runs realtime distributed auctions for every ad that goes through the network. In effect, it operates an online exchange similar to stock-trading ECNs such as Island and Archipelago.

By matching what advertisers are willing to pay for space with what publishers are willing to accept, ExperClick seeks to create a more efficient market. The service is in beta testing as the company looks for funding to launch it commercially.

These alternatives could involve different prices, or simply different user scenarios. In taking this approach, Homer drew on his experience running the Netscape.com portal and serving on the board of Tivo. "From a user perspective, we thought that a user would be best served by expanding their flexibility in delivery options," he says. He continues: "The theory is that for some things you may want it immediately, but for many things you may prefer to have the system go off and get them for you at times when you're not using your computer."

Kontiki launched its public beta in October. So far, with 50,000 nodes on the network, the company sees more than half the bits on the network being served from peers rather than from origin servers. For popular content, says Homer, the percentage is over 95 percent. As a result, Kontiki can price its service to content owners significantly lower than CDN solutions. Its standard pricing starts at one-third of what CDNs charge.

Kontiki has also built features to make itself appealing to enterprise customers. These include access controls, firewall navigation, secure transmission and rights-management capability so that content delivered through Kontiki can't be saved outside the systems or viewed elsewhere. Kontiki also allows enterprise customers to set local policies for bandwidth utilization, and to perform other administrative func-

tions. Though it moves content directly between peers, Kontiki employs central management servers for reliability and performance optimization.

Homer asserts that although many startups are working on some form of P2P content delivery, none of the others have proven the real-world scalability of their networks. Kontiki has more than 20 customers, including Palm, Sony Pictures, Tivo, Amazon.com, McAfee.com, CNet and VeriSign. Most are paying, and the rest are in pilot trials.

Uprizer: rebels with a cause

Uprizer co-founder and cto Ian Clarke gained notoriety as the primary creator of Freenet, an open-source P2P file-sharing platform designed for maximum anonymity. Freenet goes beyond Napster and even Gnutella in its resistance to restrictions from governments and private copyright or reputation holders. It allows for cryptographically secure anonymity and decentralizes every significant element of the network, to eliminate all single points of failure. Clarke, who developed Freenet while a computer-science grad student in the UK, has now moved to Los Angeles and is taking what he learned from Freenet and using it to build a commercial service at Uprizer.

UPRIZER INFO
Headquarters: Santa Monica, CA
Founded: April 2001
Employees: 18
Funding: $4 million from Intel Capital, Kline Hawkes & Co. and Shugart Venture Fund
URL: www.uprizer.com

Clarke says that although Freenet was designed with free speech in mind, he and other developers on the project quickly saw other applications for the core technology. "In its most generic form, I would characterize this technology as being, in effect, a black box which gets information to people who want it," he explains. Freenet and Karma, Uprizer's proprietary platform, virtualize access to files on the network. In other words, users need only know *what* they're looking for, not *where* it's located.

The Web's URLs, Clarke says, are like analog audio cassettes. To find a song (or in the early days of personal computers, a piece of software), you need to keep track of where it's stored. With a compact disc or a hard drive, the device handles that location process for you. Where such digital devices use a searchable index to virtualize access, however, Freenet and other P2P exchanges keep multiple copies of files throughout the network and employ algorithms and messaging protocols to find an available copy.

THE BEST INVENTIONS? A CAUTIONARY TALE ABOUT PATENTS

Allcast, a service provided by New York-based startup Diffuse Networks, provides P2P content distribution software for live Webcasting. It targets its solution at companies that want to organize large live events without crushing bandwidth and server costs.

As its primary differentiator from competitors, Allcast points to the patent it was issued in 1999 for P2P content distribution, claiming that it "invented" the technology. In its marketing materials, Allcast has implied that its competitors resemble Napster in encouraging activities not fully subject to intellectual property protection.

We're not in a position to offer a legal interpretation of the Allcast patent. But relying on patents as a business tactic is problematic. Given the number of companies working on some form of P2P content distribution, it seems likely that, even if valid, the Allcast patent would have narrow applicability because of prior art or limits in its claims. At least one other P2P content distribution company, Chaincast, has received a patent, and most of the others have filed applications.

We believe software patents aren't bad per se, since they can provide inventors with useful incentives to innovate. And like them or not, they are a widespread reality. IBM announced that it received over 3,000 US patents in 2001, and most other large technology companies have significant patent portfolios as well.

The danger is that patents are becoming a substitute for innovation rather than a means for it. For example, Gemstar has built an extremely lucrative business around licensing its patents on electronic program guides for television, but in the process has made it difficult for others to create better guides. In response, Carl Malamud, formerly of Invisible Worlds (SEE **RELEASE 1.0**, MARCH 2000), has launched a non-profit open-source effort called NetTopBox to develop more open program guides.

Concern about the over-use of patents reached a boiling point in 2000 when Internet companies such as Amazon.com and Priceline.com sought to enforce patents for business methods and widely implemented technical approaches. When many startups that trumpeted their patents collapsed because their business fundamentals weren't sound, the outcry died down. It picked up again recently, though, when the World Wide Web Consortium (W3C) proposed a new patent policy for the technical standards it issues.

W3C proposed expressly to allow its standards to incorporate patented technology on a "reasonable and non-discriminatory" (RAND) licensing basis, as well as a royalty-free (RF) basis. With RAND licenses, users of the standard must pay the patent-holder, so long as the royalties are reasonable and available equally to all (as defined by W3C). W3C's proposal provoked loud objections from many participants in the Internet standards process, and from the open-source community. In response, W3C opened up the deliberation process of its patent policy working group, and is re-evaluating its proposal.

The issue is less black-and-white than it appears. Many standards bodies, including the Internet Engineering Task Force, allow RAND licensing. Though it is common belief that W3C today requires RF licensing of technology for its standards, that has never been formally codified.

Ultimately, there is a market for standards as for anything else. There is a value in standards free from royalties, which encourage adoption and reassure participants that no company will benefit disproportionately from a standard. The Web wouldn't have happened without core standards such as HTML, XML and HTTP being freely available and not controlled by any party. There's also a place for private "standards" or those requiring paid licenses, but those should be the exception rather than the rule. Whether that's the case will depend on how companies participating in the standards process act.

Allcast is by no means the worst offender when it comes to patents. It's competing for customers with its technology rather than purely wielding a legal sword. We hope the market will continue to encourage that approach.

Uprizer, like most of its competitors, sees enterprises as the initial market with consumer media distribution becoming significant in the future. Most large corporations are deploying enterprise portals (SEE **RELEASE 1.0**, FEBRUARY 1999) to aggregate information for their employees. With large files such as PowerPoint presentations, video clips and training materials being offered on those portals, says Uprizer ceo

Dave Scantling, "The workload that's now being required is getting to the level where it starts to look like the workload of some of the more popular open Internet sites."

Uprizer reduces the costs for bandwidth and network infrastructure to handle these large files, by retrieving content whenever possible from other local users. For infrequently accessed content, Uprizer provides a backstop server that supplements the distributed network with central storage.

Because it is fully distributed, Uprizer's network routes around congestion automatically, like the Internet itself. Uprizer goes beyond the Internet, however, in that it factors in demand for content. As nodes in the network respond to requests, copies of documents are stored along the path those documents take to reach their destination. Popular documents are automatically cached more widely, and popular nodes automatically connect to more of the network.

"You get this positive feedback loop where computers that successfully answer requests for data are more likely to get asked for similar data in the future," Clarke explains. As a result, Clarke says, Uprizer's retrieval times scale with the logarithm of network size, a much gentler curve than with centralized approaches. The decentralized approach also makes the system more robust. A study of Freenet (SEE RESOURCES SECTION) showed only a limited increase in the average number of hops to a piece of content when up to 30 percent of the nodes were randomly switched off, or up to 18 percent of the busiest nodes.

Uprizer's lack of a central directory allows it to work even in the presence of firewalls and network address translation (NAT) devices (SEE **RELEASE 1.0**, MAY 1999), which limit the free flow of data across much of today's Net. "NATs and firewalls are water to the Wicked Witch of P2P," Clarke quips. With Uprizer, nodes behind a firewall or NAT (for example, inside an enterprise) self-organize into their own mini-distribution network. That's not the same as working *across* a firewall, because the internal nodes don't have full two-way visibility with the rest of the network, but it's better than nothing.

More efficient downloading from portals is the first application Uprizer is delivering on its Karma platform. Once the Karma clients are in place, additional applications can be created on top, using standard hypertext transfer protocol (HTTP) as the application interface. To deploy an application, the customer simply places it on the backstop server and tells employees to request it. Using the distributed network, the new app propagates out automatically.

Uprizer will launch its service next month. It plans to price based on the number of nodes deployed, because the value in its system comes from the clients rather than servers. It has three pilot customers including IBM, which ran the software through its own simulation labs to confirm its performance.

Blue Falcon: distributed streaming takes flight

"Our mission is to design software that can help optimize networks," says Blue Falcon ceo Jay Haynes. Blue Falcon, formerly Static Online, has been working on the problem of distributed content distribution since 1995. It spent most of that time in R&D mode; the company surfaced and began to sign up customers last year. That extended development period gives the company its edge, argues Haynes. Blue Falcon's solution takes into account the entire supply chain for delivering rich media content, including hosting and co-location providers, CDNs and end-users. "Our goal is to make network administrators happy, users happy and content providers profitable," says Haynes.

BLUE FALCON INFO
Headquarters: Los Angeles, CA
Founded: 1995
Employees: 27
Funding: $12 million from Draper Fisher Jurvetson, Zone Ventures and Wasatch Venture Fund
URL: www.bluefalcon.com

Blue Falcon works across any CDN and picks up where those networks leave off – the unreliable and low-speed connections at the very edges of the Internet. CDNs work by, in effect, creating a reliable parallel network on top of the Internet, and delivering content to the edges of that network. Unlike a CDN, which knows exactly where its servers are and has control over them, distributed content distribution solutions are subject to the vagaries of clients within the control of end-users. "You want to guarantee the quality of service a CDN can provide, but you want to solve the last-mile packet loss that only intelligent peer algorithms can address," explains chief architect Damien Stolarz.

For example, if one node on a high-speed cable modem connection suddenly drops off the network because its user shuts down his or her computer, the system must be able to self-heal and quickly reassign the traffic elsewhere. The switch must happen fast enough that users downstream don't notice an interruption in what they hear or see, and it must avoid sending everyone back to the origin server in a way that would overload it. In Blue Falcon's system, every peer constantly monitors network topology and quality of service, and the network is organized into a hierarchy so that nodes are used more if they have higher bandwidth and reliability. The company also uses central tracking and control servers to manage the network in realtime.

Like Uprizer, Blue Falcon allows its nodes to self-organize into mini-networks behind firewalls or NATs. Stolarz heads the firewall committee for the Intel-founded Peer-to-Peer Working Group, and Blue Falcon believes it handles firewalls better than competitors. In Blue Falcon's first commercial deployment, 96 percent of clients behind firewalls received the outbound streams, and 95 percent of those were able to reflect the stream outside the firewall to other nodes.

Blue Falcon is initially going after streaming online radio broadcasting, which Haynes says is a market that grew 300 percent last year, with one-third of online households now listening to streaming radio on a regular basis. The biggest problem in the market (other than copyright and licensing issues) is cost; most streaming providers lose money because of the bandwidth expenses.

Blue Falcon's first customer is Radio Free Virgin, a streaming radio network operated by Virgin Records. The company says that Virgin has so far experienced 40- to 75-percent cost savings for streaming using Blue Falcon's software. Blue Falcon also has a deal with Salem Broadcasting, which owns 80 radio stations and has 1600 affiliates. Later this quarter, Blue Falcon will ship its enterprise product, designed for corporate intranets. Though the sales cycle for enterprises is longer than for consumer media, the company has seen enterprise streaming demand pick up since September 11 as an alternative to corporate travel.

Radiance: against the P2P grain

Radiance is betting that distributed content distribution will be a big market in enterprises and eventually consumer media. . . but not based on a P2P architecture. Founder and ceo Ash Munshi has three business-to-business startups under his belt: Commerce Engine (which became Ariba), SpecialtyMD (acquired by Ventro) and Vivecon (where he is still a director). Based on his experience with enterprise customers, he's convinced that corporate IT organizations want to control their networks and what's on all their desktops. Moreover, when it comes to content delivery, enterprises want guarantees on delivery time and quality of service that can't be achieved with a fully decentralized P2P approach.

RADIANCE INFO
Headquarters: Los Altos, CA
Founded: July 2000
Employees: 27
Funding: $8 million from Sutter Hill Ventures and individuals
URL: www.radiance.com

"Bandwidth is not the issue as much as the management of the bandwidth and all the deliveries in contention for it," explains Munshi. And that management is best done centrally, he says. That doesn't mean Radiance rejects the idea of decentralizing

NEXTPAGE: DISTRIBUTED CONTENT MANAGEMENT

The content-management market (SEE **RELEASE 1.0**, SEPTEMBER 1998) remains healthy because virtually every decent-sized company has one or more Websites, and managing those Websites manually simply doesn't scale. However, reduced IT spending has taken a bite out of the fantastic growth rates and margins early leaders in this space enjoyed.

NextPage is unique in the content-management market in its distributed approach. Larger competitors such as Vignette and Interwoven integrate deeply with the infrastructure within an enterprise, which makes them a core e-business platform but limits their ability to handle activities that go outside the enterprise.

"The centralized model doesn't work for all types of applications," says ceo Bill Wesemann. "Our sweet spot tends to be connecting not only distributed content, but distributed teams of people with that content, in the context of a business process." NextPage focuses on vertical markets with significant levels of inter-organization activity, such as legal, accounting, financial services and high-tech. About half its customers, and the fastest growing segment, use NextPage for processes that operate outside company boundaries, says evp of marketing Darren Lee.

NextPage's platform, NXT3, virtually connects the distributed information sources and makes them appear integrated to the user. Unlike syndication (SEE **RELEASE 1.0**, JULY/AUGUST 1999), in which content is copied and integrated with other content locally, NextPage keeps objects where they are. The information stays put, but the NextPage platform tracks it and makes it appear "local" to the user.

NextPage uses the standard simple object access protocol (SEE **RELEASE 1.0**, SEPTEMBER 2001) to exchange and normalize information between local content directories, assembling meta-indexes so that users can search or manipulate content transparently, regardless of its physical location.

The company, which now has 225 customers, was able to grow revenues 15 percent in 2001 despite the difficult environment, and it's projecting 50 percent growth this year. (Vignette saw revenues fall 20 percent last year, while Interwoven reported 10-percent year-over-year growth in its most recent quarter.)

NextPage is an example of a company that touted the P2P label when the concept was hot a year ago, even though it differed from most players in the P2P world. Today it talks about business networks and distributed content. "None of our customers buy this and say, 'I needed a peer-to-peer solution.' They all come and say, 'I need a solution, and a centralized approach doesn't do what I need it to do'," explains Lee.

The company in October launched Matrix, its first set of applications on top of NXT3. Matrix offers tools for collaboration and integration of business processes with the platform.

content distribution and serving objects from points closer to the edge of the network; it just doesn't believe those points should all be other end-users (though it could support such a configuration if a customer so desired). Svp of marketing John McCrea describes Radiance's position in a nutshell: "We're very highly distributed, but very strongly centrally managed."

Where P2P approaches and traditional caching depend on recipients to request the content they want, Radiance focuses on guaranteed, scheduled delivery for the content owner. "In both the enterprise space and the consumer entertainment space, edge-caching and peer-to-peer approaches fall short of the business need-to-know that a piece of content got to the right person or persons, by the time it needed to get there, with end-to-end content security," says McCrea.

Radiance has designed its system as a comprehensive solution for reliable, efficient delivery of digital packages. Those packages can be anything – PowerPoint files, video clips, streaming audio files and so forth. Radiance manages the delivery of those files and also the metadata that allows individual objects to be grouped together into logical combinations. For example, a field sales organization could package up several hundred megabytes of content into a comprehensive set of sales tools, including video customer testimonials, PowerPoint presentations, data sheets in PDF format and image-rich Web pages.

Delivery of large objects across enterprises is a particularly acute problem when content goes to branch offices or over the Net to partners. The salesperson who needs the latest training video and competitive positioning presentation on the road doesn't have the same luxury as someone sitting at headquarters on a 100-megabit-per-second LAN. The default solution today – email attachments – creates problems of network congestion and security risks. With companies becoming more decentralized and linking themselves more closely to partners, it makes sense to create a content delivery layer that floats across geography and company boundaries.

Radiance provides software that runs on standard platforms and commodity hardware. It sells two products: distribution servers that sit at the data center and manage content across the network, and delivery servers that are deployed throughout the network, in whatever topology makes sense for a particular enterprise. "Ultimately the name of the game to treat every delivery like a transaction," Munshi stresses. "The only way to ensure quality of service is to use a system like ours," because of its strong central management capability. Radiance hasn't announced specific pricing, but it plans to sell enterprise software licenses rather than using a service model.

P2P, Wherefore Art Thou?

Distributed content distribution is an example of a P2P (or P2P-like) technology making headway in the enterprise world. Given the level of excitement that P2P generated, it's worth a brief update on the space.

In our P2P survey a year ago (SEE **RELEASE 1.0**, NOVEMBER AND DECEMBER 2000), we found well over a hundred startups chasing this opportunity. Today, many have failed. Napster has been shut down under legal pressure. Where companies once raced to

connect themselves with the trend, no matter how tenuous the connection, they now do the opposite, looking to avoid guilt by association.

Amid the high-profile failures, though, some P2P companies are addressing legitimate markets. It's easy to view P2P like the dead parrot in the famous Monty Python sketch: The owner insists that it's "just resting." The P2P companies making headway today aren't promising to change the world overnight, and they don't view the choice of centralized or decentralized architectures as all-or-nothing. Their focus is the functionality they offer – whether delivering massive computational power cheaply or helping business teams get work done when they aren't all on the same corporate network – not the architecture they use to provide it.

What's hot and what's not

The four plus one categories of P2P software we described last year – exchanges, collaboration, information discovery, distributed computing plus infrastructure – remain a useful framework for examining the space. P2P content distribution, which we cover above, is a P2P infrastructure service that is just now going commercial. In the other areas, the low-hanging business opportunities have become clearer.

P2P file-sharing exchanges continue to enjoy heavy usage, but suffer from serious legal concerns and a dearth of proven business models. As expected, fully decentralized systems have sprung up to take Napster's place. There's also Audiogalaxy, which marries a P2P file-sharing service with a Web front-end.

The most popular unlicensed music service today isn't Gnutella or Freenet, the early heirs apparent, but a technology/company not even on the market 18 months ago: FastTrack. Services licensing the FastTrack technology, which was developed by a small company in Amsterdam, include Kazaa, Morpheus and Grokster. (Maybe software licensing is the real business model here!) Together they now generate a higher level of usage than Napster at its peak. FastTrack is beta testing its own P2P content-distribution service, CloudLoad, to enhance services licensing its technology.

Meanwhile, Napster is readying its subscription service, as are two services backed by major record labels (MusicNet and PressPlay) and two from independent startups (FullAudio and Listen.com's Rhapsody). It will take these services time to find their legs. Each has a different lineup of major and independent labels providing content; for now, there's no place to find all the music you can buy on CD at Amazon.com or Barnes & Noble. Each has its rights-management technology that limits users' free-

dom to move around the music they've downloaded. And all are experimenting with pricing schemes. With Napster-like services still available, this is a recipe for confusion, at least initially.

P2P file sharing definitely won't go away, but it's not clear that it will support a viable business. Evasion of copyright protection may fulfill real demand, but that doesn't help pay the bills for the network operator and software provider. The copyright-holding industries have missed a big opportunity to re-connect with their customers, and they are threatening innovation by their extreme defense of restrictions on digital use of copyrighted material. However, without any copyright law there wouldn't be as many incentives for creators to produce or distribute content.

Breaking down the value proposition of P2P file sharing, it becomes clear that the two primary advantages of the P2P architecture flow into other application categories. By transferring files directly between users, P2P exchanges avoid the expense of centralized file repositories and the bandwidth between them and users. However, if what you really want is more efficient distributed content delivery, there are other ways to get there (SEE ABOVE). The second value of P2P exchange is that it makes it easier to transfer files between distributed groups of users, especially in business contexts where teams may not be in the same place or the same company. But if *that's* the goal, what's needed are distributed collaboration mechanisms (something we plan to cover in the next few months. . .).

The P2P area that has advanced the least is information discovery. Infrasearch, which had been developing a P2P search engine, was acquired by Sun and rolled into Sun's JXTA effort (SEE **RELEASE 1.0**, MARCH 2001). OpenCOLA remains in business, but it has narrowed its focus to enterprise search solutions. As we noted in our knowledge-management report (SEE **RELEASE 1.0**, JUNE 2001), there's a need for more distributed, human-scale ways to organize information and share knowledge. NextPage (SEE PAGE 14), with its distributed indexes to tie together dispersed content, is one company moving in this direction.

Distributed computing has gained traction, but almost entirely using internal enterprise networks rather than consumer PCs over the Net. IBM, Sun and the Globus Project continue to do significant work in this area. Among startups, Popular Power (SEE **RELEASE 1.0**, DECEMBER 2000) failed to get funding, but Platform Computing, Avaki (formerly Applied Metacomputing), DataSynapse and others are gaining customers in verticals needing vast amounts of computation on demand (financial simulations, energy and drug discovery, plus academic research and the military).

Finding the edge

As P2P systems mature, basic questions keep coming up: What goes in the middle of the network, what goes at the edges, and, often overlooked, what's in between? There's no right answer. Napster puts content at the edges, metadata (directories and user information) at the center, and a proprietary application platform between them. Uprizer (SEE PAGE 9) keeps the metadata at the edges as well, and uses standards-based HTTP transport between its desktop nodes. Groove (SEE **RELEASE 1.0**, JUNE 2001 AND NOVEMBER 2000) can run with everything decentralized, but is most likely to be used with central servers to augment the end-user nodes.

For applications such as content distribution, the tension is between central management for reliability and control versus decentralization for user empowerment and robustness in the face of local failures. As described above, most companies use a hybrid approach for this reason, but they differ in the degree of decentralization.

The same issues arise in communications. Telephone companies believe in delivering network services from the core, through application platforms they tightly control. Broadband startups such as Soma Networks and Narad Networks (SEE **RELEASE 1.0**, JULY/AUGUST 2001) can deliver services at the edge, but the intelligence is still within the network. The alternative vision of user-driven networking makes the network purely a dumb pipe for services defined by end-users.

In communications, the argument for intelligence in the network is economic: The service providers need a business model to build out the capability, and that requires more than just dumb-pipe commodity bandwidth. At least, so they claim. We suspect that providers willing to focus on pure connectivity to the end user, or to offer open platforms for network-based applications, will find that being a dumb pipe need not be such a bad business after all (SEE **RELEASE 1.0**, FEBRUARY 1999).

A nagging question remains about what ties together the intelligent units at the edge. At first, everyone has had to build their own special-purpose platform, but there's great pressure for standards so that new applications can build on existing infrastructure. Projects such as Sun's JXTA and Microsoft's .Net, along with Web-services standards (SEE **RELEASE 1.0**, SEPTEMBER AND OCTOBER 2001), are beginning to deliver usable elements, and the open-source Tristero project from Freenet developers Brandon Wiley and Steven Hazel is also targeted at this need.

The deep issue isn't so much what becomes the mediation layer to support various P2P services, but who controls it and what control it exerts over the rest of the

ecosystem. In other words, what functions as the operating system (OS)? In the PC ecosystem, the OS became the control point that sucked value from the hardware vendors on one side and the application developers on the other. In the open model of Unix and arguably Java and Web services, the equivalent intermediation functions are built on standards, so they remain a commodity.

Back to content distribution

All this is somewhat premature in the distributed distribution space, which is just now getting real. Before they can take their place in the pantheon of distributed services, P2P content-distribution vendors must prove out their business model.

In their favor is a long-term trend – the growth of network traffic and especially rich media – and a favorable economic structure. Whereas the cost of traditional "unicast" Internet delivery increases with every additional user, and CDNs have high fixed costs of deploying thousands of local caching servers, P2P content distribution starts cheaply and becomes *more* efficient as each item of content is more heavily requested. The more popular the content, the more likely you can get it from a nearby peer rather than the origin server.

The challenge is that if distributed content delivery is competing primarily on price, that may not be enough. With the costs of their network buildouts sunk, CDNs or streaming media delivery services will be willing to lower prices to fend off competitors, and customers will need a strong incentive to jump to an unproven new technology. Moreover, for consumer applications, distributed content delivery takes advantage of the fact that Internet service providers generally don't charge for upstream bandwidth, but that may change if these services significantly increase the level of traffic moving upstream from one end-user to another.

As with CDNs themselves (SEE **RELEASE 1.0**, DECEMBER 1999), distributed distribution services will eventually have to offer value-added applications and services. Moving bits efficiently is a necessity, but it may not be sufficient. Right now, these services (with the exception of Kontiki) operate behind the scenes, making life easier for network administrators and content providers, but they are largely invisible to end-users. They will become more interesting if they become more visible, enabling new applications beyond plain vanilla content delivery. ■ R 1.0

COMING SOON

- Online collaboration tools.
- Plug-and-play VPNs.

- And much more. . . (If you know of any good examples of the categories listed above, please let us know.)

Resources & Contact Information

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Roy de Souza, **Zedo,** 1 (650) 814-8155; roy@zedo.com

For further reading:

Stanley Milgram, "The Small World Problem," Psychology Today, 2: 60-67 (1967)

H. Russell Bernard et al, "Estimating the Ripple Effect of a Disaster," Connections 24(2): 18-22 (2001) (using small-worlds analysis to calculate how close a random person is to a victim of the September 11 attacks)

D.J. Watts and S.H. Strogatz, "Collective Dynamics of 'Small-World' Networks," Nature 303, at p. 440 (1998)

Columbia University Dept. of Sociology Small World Research Project — http://smallworld.sociology.columbia.edu (attempting to replicate Milgram's "six degrees of separation" experiment using email)

Theodore Hong, "Performance," in **Peer-to-Peer: Harnessing the Power of Disruptive Technologies** (O'Reilly 2001) at p. 203 (includes study of Freenet robustness and scalability)

Calendar of High-Tech Events

2002

JANUARY 28-31 — **O'REILLY BIOINFORMATICS TECHNOLOGY CONFERENCE** - Tucson, AZ. Covers the application of computing power to life sciences research. Will this be the next hot sector in high-tech? O'Reilly follows the hackers to find out. To register, call 1 (707) 829-0515; fax, 1 (707) 823-9746, or visit conferences.oreilly.com/biocon.

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FEBRUARY 4-8 — **MILIA** - Cannes, France. Come play with the next generation of interactive entertainment; the expo features the latest interactive content and TV, games,leisure software, broadband and wireless entertainment. Register online or contact, Laurine Garaude,telephone 33(1)41 90 46 30; by fax 33(1) 41 90 44 70, or by email laurine.garaude@reedmidem.com www.milia.com

FEBRUARY 10-12 — **DEMO 2002** - Phoenix, AZ. Check out this year's crop of new startups and gadgets! For information, call Anna Aquino at 1 (800) 633-4312, or email registrar@idgexecforums.com. www.idgexecforums.com/demo

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MARCH 8-12 — **SXSW INTERACTIVE** - Austin. TX. This offshoot of the South-by-Southwest independnt film festival offers heaping servings of online community, featuring thinkers, designers and Webloggers. For more information, call 1 (512) 467-7979; fax, 1 (512) 451-0754; email inter@sxsw.com. Register at www.sxsw.com/interactive.

MARCH 10-14 — **ICANN MEETING** - Accra, Ghana. The Internet Corporation for Assigned Names and Numbers brings its work on Internet governance to Africa. More information will be available soon at www.icann.org. E

MARCH 13-20 — **CEBIT 2002** - Hannover, Germany. The biggest European technology event, officially dubbed the World Business Fair for Office Automation, Information Technology and Telecommunications. For further information, call 49 (511) 89-0; www.cebit.de

MARCH 24-26 — **PC FORUM** - Scottsdale, AZ. EDventure Holdings' premier conference, this year celebrating its 25th anniversary. Our theme is "Back to the Frontier," and our speakers include Craig Barrett (Intel), Jean-Marie Messier (Vivendi Universal), Joe Nacchio (Qwest), Steve Perlman (Moxi Digital), Hilary Rosen (RIAA) and Rick Belluzzo (Microsoft). Registration is now open at www.edventure.com/pcforum. E K

Calendar of High-Tech Events

MARCH 25-29	**JAVA ONE** - San Francisco, CA. The world's largest developer conference and geekfest for Java developers. Hot topics will include Web services,wireless and handheld devices and emerging technologies. To register, call 1 (888) 886-8769; fax, 1 (781) 449-2674, or visit servlet.java.sun.com/javaone.
APRIL 16-19	**CFP2002**: The Twelfth Conference on Computers, Freedom & Privacy - San Francisco, CA. Continuing the debate on rights and wrongs in the online world. Speakers include California Attorney General Bill Lockyer, author Bruce Sterling and John Perry Barlow. For more information, email feedback@cfp2002.org. Register at www.cfp2002.org.
APRIL 16-20	**2002 EURO-CHINA FORUM ON THE INFORMATION SOCIETY** - Beijing, China. An exhibition of European technology and service and a conference focusing on challenges and developments of the information society in Europe and China. Contact EuroChina2002 Help Desk, 33 (493) 958-530; email: eurochina@sigma-consultants.fr. www.eurochina2002.com/bandeau1.htm
APRIL 20-25	**CHI 2002** - Minneapolis, MN. Leading international forum for the exchange of ideas and information about computer-human interaction. For information, contact CHI at 1 (410) 263-5382, or by email at chi2002-office@acm.org. www.acm.org/sigchi/chi2002
APRIL 22-26	**INTERNATIONAL CONGRESS OF INFORMATION 2002** - Havana, Cuba. Sponsored by The Institute of Scientific and Technological Information of the Cuban Ministry of Science, Technology and Environment, the INFO 2002 theme is "Information, Knowledge and Society. Challenges of a New Era." Official languages are English and Spanish. Contact Nicolás Garriga Méndez, 53 (7)635-500, info@idict.cu. www.idict.cu/info2002/venglish.htm
MAY 7-11	**WWW 2002** - Honolulu, HI. The Eleventh World Wide Web Conference, organized by the World Wide Web Consortium. For more information, email info@www2002.org. www.www2002.org.
MAY 12-17	**CONGRESS ON EVOLUTIONARY COMPUTATION** - Honolulu, Hawaii. Held as part of the WCCI World Congress on Computational Intelligence. The emphasis of the Congress will be on original theories and novel applications of evolutionary computation techniques. www.wcci2002.org
MAY 29-30	**RSA CONFERENCE 2002** - Tokyo, Japan. Feeling insecure? Corporate security experts, mathematics and cryptography researchers examine Internet telecommunications technology, privacy issues, and e-business security. For information, call 81 (3) 5549-1313 or email rsa-s@key3media.co.jp. www.rsaconference.com

E Events Esther plans to attend.
K Events Kevin plans to attend.

Lack of a symbol is no indication of lack of merit. The full, current calendar is available on our Website, www.edventure.com. Please contact Irene Lawrence (irene@edventure.com) to let us know about other events we should include.

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Joseph Nacchio (Qwest)
Jerry Parrick (Yipes)
Steve Perlman (Moxi Digital)
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Mike Volpi (Cisco Systems)
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